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## **Belt Retractor**

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### Technical Field

- 5       The invention relates to a belt retractor for a vehicle safety belt.

### Background of the Invention

A conventional belt retractor normally has a frame and a belt spool which is rotatably mounted in the frame, and at least one locking toothing which is connected with the belt spool.

- 10       To block the belt spool against a rotation in the belt band unwinding direction, usually a locking system is provided, which has a locking catch supported on the frame, and a locking toothing connected with the belt spool. The locking catch can be guided by an automatic blocking arrangement into the locking toothing in a vehicle-sensitive and/or belt band-sensitive manner, so that the belt spool is  
15       blocked.

- In order to ensure that the locking catch also remains engaged securely in the locking toothing in the case of high stresses, usually it is ensured through the geometry of the locking catch and/or of the locking toothing, that the forces exerted by the locking toothing onto the locking catch exert a torque onto the  
20       locking catch, urging the locking catch towards the locking toothing. However, the result of this is that the locking catch can only be moved out from the locking toothing again when the locking toothing and therefore the belt spool carry out a specific reverse rotation in the belt band winding direction. Otherwise, the friction forces between the locking catch and the locking toothing could not be overcome.

- 25       The object of the invention consists in providing a belt retractor of the type initially mentioned, in which owing to structurally simple steps on the one hand a

secure blocking of the belt spool and, on the other hand, a simple unlocking of the locking toothing can be achieved.

#### Brief Summary of the Invention

According to the invention, a belt retractor for a vehicle safety belt comprises  
5 a frame and a belt spool which is rotatably mounted in the frame, and at least one  
locking toothing which is connected with the belt spool. A first locking catch and  
a second locking catch are provided, which are supported on the frame and can  
engage into the at least one locking toothing. The first locking catch is able to  
swing about a point of rotation which is arranged such that with the first locking  
10 catch guided into the locking toothing a virtual line, which passes through a point  
of contact between the first locking catch and the locking toothing and stands  
perpendicularly on a tooth face in the point of contact, runs between the point of  
rotation and a rotation axis of the belt spool. The second locking catch is able to  
swing about a point of rotation which is arranged such that with the second  
15 locking catch guided into the locking toothing, a virtual line which passes through  
a point of contact between the second locking catch and the locking toothing and  
stands perpendicularly on a tooth face in the point of contact, runs on the side of  
the point of rotation facing away from the rotation axis of the belt spool.

In this way, the first locking catch is constructed and arranged such that when  
20 it is in a state guided into the locking toothing, a torque acts on it which urges it  
away from the locking toothing or which in a borderline case can also become  
zero. The second locking catch, on the other hand, is constructed and arranged  
such that when it is in a state guided into the locking toothing, a torque acts on it  
which urges it into the locking toothing. The invention is based on the basic idea  
25 of providing a division of work to the effect that the first locking catch is provided  
for a normal situation blocking of the belt spool and the second locking catch is  
provided for a crash situation blocking of the belt spool. The term "normal  
situation blocking" is understood here to mean a blocking, such as occurs in the  
normal operation of the vehicle, for example on sharp braking, on driving round a  
30 bend, etc. The term "crash situation blocking", on the other hand, is understood to

mean a blocking which in the case of a vehicle accident serves to hold back the vehicle occupant. The operating blocking and the crash situation blocking therefore differ on the one hand by the forces which are in action and on the other hand by the frequency of occurrence: The forces occurring during normal operation blocking in the belt band lie at a maximum in the order of magnitude of the weight of the vehicle occupant, whereas in crash situation blocking the force in the belt band is a multiple of the weight of the vehicle occupant. The normal situation blocking can occur several thousand times during the life of a belt retractor, whereas the crash situation blocking usually only occurs on one single occasion; then the belt retractor should be replaced by a new one. The first locking catch, which is used for the normal situation blocking, is distinguished in that it can be easily withdrawn from the locking toothing, because it is in any case pressed out from the locking toothing by the torque acting on it, or in that the acting torque is equal to zero in a borderline case, when the effective lever arm between the point of rotation of the catch and its point of contact with the locking toothing becomes zero. Therefore, no reverse rotation of the belt spool is necessary in order to disengage the locking catch and to free the belt spool again. Of course, the first locking catch can only be stressed up to a certain level, because otherwise the acting torque can not be taken up by the blocking mechanism - which guides the first locking catch into the locking toothing - and the locking catch would be forced out from the locking toothing. Above this level, the second locking catch becomes effective. Because the torque affecting the second locking catch urges it into the locking toothing, the hold of the second locking catch in the locking toothing improves with increasing stress on its own. The fact that the second locking catch can only be released from the second locking toothing after a reverse rotation of the belt spool is of minor importance in practice.

In an embodiment according to the invention, the first locking catch can be constructed so as to be flexible, so that with a torque acting on it above the level of the normal situation blocking, it loses its locking effect, e.g. by bending or breaking along a predetermined breaking point, whereby the second locking catch

comes into engagement into the locking toothing. For this, the locking catches in each case can be constructed as separate elements or as one element in the form of a tandem catch, in which the first locking catch is constructed as an additional edge alongside the second locking catch.

5        In a further embodiment according to the invention, a belt retractor of the type initially mentioned is constructed such that first locking toothing and second locking toothing are provided, which are each connected with the belt spool. This makes it possible for the two locking catches to use respectively adapted locking toothings.

10        According to an embodiment of the invention, provision is made that the teeth of the first locking toothing are constructed without undercut, and the teeth of the second locking toothing are constructed with undercut. The locking toothing without undercut is biased against the locking toothing with undercut by means of a spring and precedes it through the spring action. The teeth of the first locking  
15        catch are likewise constructed without undercut, whereas the teeth of the second locking catch are constructed with undercut. In the case of a locking process with the locking catches engaging, firstly the locking catch without undercut comes into engagement into the locking toothing without undercut, in order to carry out a normal situation blocking. In this case, an unlocking of the locking catch is  
20        possible without a reverse rotation of the belt spool, and can take place almost without any expenditure of force with the spring rendered powerless. After exceeding a threshold force acting through the belt onto the belt spool, which results from the spring parameters, the locking toothing with undercut rotate further against the spring force, so that the locking catch with undercut comes into  
25        engagement into it. With an engagement of the locking catch with undercut into the locking toothing with undercut, through the rotation of the belt spool an entraining moment is produced, which brings about a complete swiveling of the locking catch and therefore ensures a secure and rapid engagement which can transfer without difficulty the high forces which occur in a crash situation  
30        blocking.

In a further embodiment, the swivel axis of the first locking catch, which is provided for the normal situation blocking, can be arranged such that the effective lever arm between the point of rotation and the point of contact between the locking catch and the locking toothing, with the locking catch guided into the locking toothing, becomes completely or at least almost zero, whereby the torque acting on the locking catch likewise becomes zero. In this way, with a blocking of the belt spool, the catch is not forced out from the locking toothing and can be held more easily in the blocking position by the blocking mechanism.

The first locking catch can be produced at a favorable cost from plastic or from another flexible material, because it does not have to be dimensioned for breaking load.

#### Brief Description of the Drawings

- Figure 1 shows in a diagrammatic side view a belt retractor with guided-in locking catches, in an embodiment according to the invention with a locking toothing without undercut and a locking toothing with undercut;

- Figure 2 shows in a diagrammatic top view the locking toothing of the belt retractor according to the invention, shown in Figure 1;

- Figure 3 shows in a diagrammatic broken side view the locking toothing without undercut with guided-in locking catch without undercut, of the belt retractor according to the invention, shown in Figure 1;

- Figure 4 shows in a diagrammatic broken side view the locking toothing with undercut with guided-in locking catch with undercut, of the belt retractor according to the invention shown, in Figure 1;

- Figure 5 shows in a diagrammatic top view the locking catches of a belt retractor according to the invention in an embodiment in which both locking catches are constructed as separate elements;

- Figure 6 shows in a diagrammatic top view the locking catches of a belt retractor according to the invention in a further embodiment, in which the locking catches are constructed as one element in the form of a tandem catch and the first locking catch is constructed as an additional edge alongside the second locking catch.

#### Detailed Description of the Preferred Embodiments

Figure 1 shows a belt retractor according to the invention for a vehicle safety belt. It consists substantially of a belt spool 1, on which a belt force  $F$  engages and which is firmly connected with a locking toothing 2 having an undercut. The locking toothing 3 without undercut is biased against the locking toothing 2 by means of a spring 4. Through the spring action, the locking toothing 3 without undercut precedes the locking toothing 2 with undercut in the direction of the force  $F$  acting on the belt spool in a locking process. In Figure 1, two pivotally mounted locking catches 5, 6 are shown in guided-in position, the second locking catch 6 of which has an undercut and the first locking catch 5 does not. The locking catches 5, 6 will be swiveled into the locking toothing 2, 3 after the triggering of the locking process. For an unlocking of the locking system, the locking catches 5, 6 are swiveled outwards again. The process of swiveling in and out can be realized in a known manner and is not the subject of the invention.

In Figure 2, there is shown the relative position of the locking toothing 2, 3 with respect to each other of a belt retractor according to the invention. The locking toothing 3 without undercut precedes the locking toothing 2 with undercut by a spring course 7, which is determined by the staggering of the locking toothings with respect to each other. Through this preceding, in a locking process in which the locking catches 5, 6 swivel into the locking toothings 2, 3, firstly the catch 5 without undercut arrives into engagement into the locking toothing 3 and blocks it. If the belt force  $F$  engaging on the belt spool now exceeds a particular threshold value  $F_{\text{threshold}}$ , then the belt spool 1 with the locking toothing 2 with undercut, firmly connected therewith, rotates further against the action of the

elastic force in the spring 4, so that the catch 6 with undercut now also can come into engagement into the locking toothing 2 with undercut.

Figure 3 shows the locking catch 5 without undercut of a belt retractor according to the invention, being in engagement in the locking toothing 3 without undercut. If, after the triggering of a locking process and the swiveling-in of the locking catch 5, the belt force  $F$  does not exceed the threshold value  $F_{\text{threshold}}$ , and if therefore an engagement of the locking catch 6 with undercut into the locking toothing 2 does not occur, then an unlocking of the system, i.e. a swiveling out of the locking catch 5 is possible without a reverse rotation of the belt spool 1, because no entraining moment acts onto the locking catch 5 via the lever arm 8. If the spring 4 is now rendered powerless, then the swiveling out of the catch 5 is also possible in an almost powerless manner. In this way, the unlocking process can be greatly simplified.

Figure 4 shows the locking catch 6 with undercut, of a belt retractor according to the invention, in engagement in the locking toothing 2 with undercut. In this case, through the belt force  $F$ , which now exceeds  $F_{\text{threshold}}$ , an entraining moment acts via the lever arm 8 onto the locking catch 6 with undercut, whereby a faster and complete gripping of the catch is brought about and the breaking load in the case of a crash can be reliably transferred.

In Figure 5, the first locking catch 5 and the second locking catch 6 of a belt retractor according to the invention in accordance with a first embodiment, are shown as two separate catches. This embodiment has the advantage that the first locking catch 5 can be produced at a favorable cost from plastic, because it does not have to be dimensioned to breaking load.

Figure 6 shows the first locking catch 5 and the second locking catch 6 of a belt retractor according to the invention in accordance with a further embodiment. Here, the two catches 5, 6 form a tandem catch, the first locking catch 5 being constructed as an additional edge alongside the second locking catch 6.